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Multiple-Path Technique for the Determination of Physico-Chemical Data Behind Shock Fronts*

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IN connection with current experimental studies on carbon formation and gas emissivities at elevated temperatures behind shock fronts, we are utilizing single-path and double-path emission and absorption measurements.[1] For observations behind shock fronts (observation times of less than about 200 μsec), we have adopted a procedure involving simultaneous spectral recording of an unchopped single-path beam and of a chopped double-path beam.

A schematic diagram of the experimental arrangement for emission studies is sketched in Fig. 1. A slotted air turbine wheel making 120 000 rpm permits frequency modulation of the double-path beam at a rate of 5 μsec, which is sufficiently rapid for our particular shock-tube applications. The mechanical chopper is to be preferred to a Kerr cell shutter[2] because the losses are minimized and because a much wider wavelength range can be covered. The single and double-path beams are observed simultaneously on the same detector and are used only to establish the intensity ratio at various wavelengths as a function of time. Hence errors associated with any variations in the receiving system, other than a loss of linearity, will not affect the observed results.

Interpretation of the measurements is based on the fact that, under suitably chosen conditions, the spectral intensity ratio for the double- and single-path experiments is a unique function of the product $P_\lambda pL$. Here P_λ is the spectral absorption coefficient, p equals the partial pressure of emitter or absorber, and L is the cell length. For chemical reaction rate studies, P_λ and L are known through independent calibrations and analysis; hence the partial pressure of emitter (or absorber) p is determined by the experimental data. In gas emissivity measurements, p and L are known and the measured intensity ratio determines the spectral absorption coefficient P_λ.

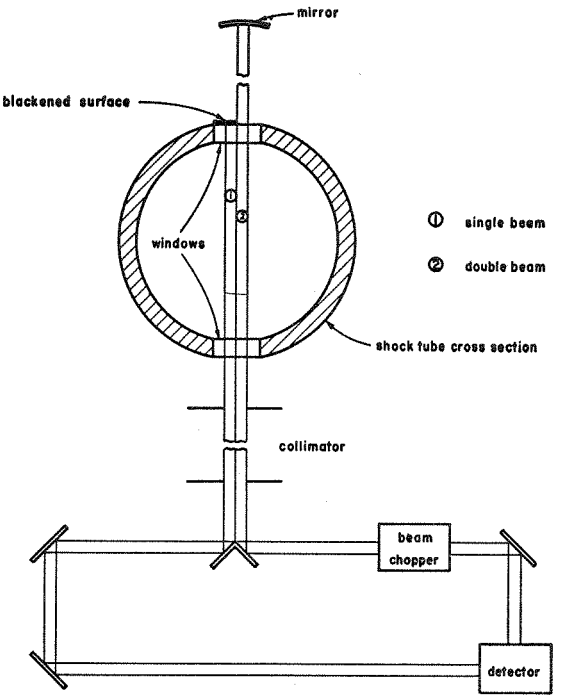

FIG. 1. Schematic diagram of the optical system used for the simultaneous determinations of single-path and double-path intensities. The axis of the shock tube is normal to the plane of the paper.

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[1] A similar procedure has been employed previously for emission studies on flames. See S. S. Penner and E. K. Björnerud, J. Chem. Phys. **23**, 143 (1955).

[2] F. Harshbarger, J. Chem. Phys. **24**, 1261 (1956).